

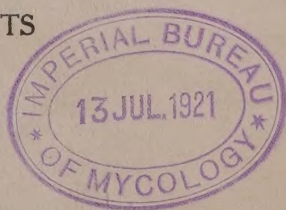
Bulletin No. 127

February, 1912

SPRAYING PRACTICE FOR ORCHARD AND GARDEN

BY S. A. BEACH

AGRICULTURAL EXPERIMENT STATION
IOWA STATE COLLEGE OF AGRICULTURE
AND THE MECHANIC ARTS



HORTICULTURAL AND FORESTRY SECTION

AMES, IOWA



STATE BOARD OF EDUCATION

Hon. J. H. Trewin, Cedar Rapids.
Hon. A. B. Funk, Spirit Lake.
Hon. George T. Baker, Davenport.
Hon. Charles R. Brenton, Dallas Center.
Hon. E. P. Schoentgen, Council Bluffs.
Hon. Parker K. Holbrook, Onawa.
Hon. D. D. Murphy, Elkader.
Hon. Roger Leavitt, Cedar Falls.

OFFICERS

Hon. J. H. Trewin, Cedar Rapids.....President
Hon. D. A. Emery, Ottumwa.....Secretary

FINANCE COMMITTEE

Hon. W. R. Boyd, President, Cedar Rapids.
Hon. Thomas Lambert, Sabula.
Hon. D. A. Emery, Secretary, Ottumwa.

STATION STAFF

E. W. Stanton, B. S., M. S., L.L.D., Acting President.
C. F. Curtiss, B. S. A., M. S. A., D. S. A., Director.
W. J. Kennedy, B. S. A., Animal Husbandman and Vice Director.
S. A. Beach, M. S. A., Horticulturist.
L. H. Pammel, B. Agr., M. S., Ph. D., Botanist.
H. E. Summers, B. S., Entomologist.
W. H. Stevenson, A. B., B. S. A., Soils.
A. W. Dox, B. S., A. M., Ph. D., Chemist.
M. Mortensen, B. S. A., Dairying.
C. H. Stange, D. V. M., Veterinarian.
J. B. Davidson, B. S. in M. E., Agricultural Engineering.
H. D. Hughes, M. S., Farm Crops.
G. B. MacDonald, B. S. F., Forester.
R. E. Buchanan, M. S., Ph. D., Bacteriologist.
Laurenz Greene, B. S., M. S. A., Experimentalist in Horticulture.
S. L. Jodidi, B. S., Ph. D., Experimentalist in Soils.
H. H. Kildee, B. S. A., Assistant in Dairy Cattle.
L. C. Burnett, M. S. A., Assistant in Farm Crops.
M. L. King, B. M. E., Experimentalist in Agricultural Engineering.
P. E. Brown, B. S., A. M., Experimentalist in Soil Bacteriology.
John M. Evvard, M. S., Experimentalist in Animal Husbandry.
A. A. Wells, B. S., M. S., Assistant in Soils.
B. W. Hammer, B. S. A., Dairy Bacteriology.
R. L. Webster, A. B., Assistant in Entomology.
Charlotte M. King, Assistant in Botany.
Harriette Kellogg, Assistant in Botany.
F. E. Colburn, Photographer.
Fred W. Beckman, Ph. B., Bulletin Editor.
W. G. Gaessler, B. S., Analytical Assistant in Chemistry.
R. E. Neidig, B. S., Research Assistant in Chemistry.

INDEX

(Note.—These references are to paragraph numbers exclusively, and not to page numbers.)

Agitators	61	Corrosive Sublimate:	
Ammoniacal Copper Carbonate and Soap	74	disinfectant for blight	2
Anthrachnose of berries	55	Cucumbers:	
Apple:		general treatment for	57
general treatment for	34	Currants:	
special spraying treatment	35	general treatment for	54
Apple Diseases:		Cut Worms:	
bitter rot	1	poisoned bait for	98
black rot	3	Dewberry:	
blight	2	general treatment for	55
blotch	4	Dilution Table for Lime Sulfur....	79
brown rot	5	Eau Celeste and Soap	73
cedar rust	6	Ferrocyanide of Potassium	72
fly speck	7	Formalin for Potato Scab	56
orange rust	10	Frost Injury	8
pink rot	11	Fungicides:	
rust	12	ammoniacal copper carbonate ...	74
scab	15	bordeaux mixture	62 to 72
sooty blotch	13	eau celeste and soap	73
storage rots	14	lime sulfur	75 to 79
Apple Insects:		self boiled lime sulfur.....	80, 81
borers	16, 17, 18	Gooseberries:	
bud moth	19	general treatment for	54
buffalo tree hopper	20	Grafting Wax	28
casebearer	21	Grape Diseases, and treatment for	52
codling moth	22	Grape Insects, and treatment for	52
curculio	23	Hellebore	96
oyster shell scale	24	Insecticides:	
plant lice	25	arsenate of lead	85, 86
San Jose scale	29	arsenite of soda	88
scurfy scale	30	black leaf 40.....	94
tent caterpillar	32	hellebore	96
woolly aphid	33	insect powder	97
Arsenate of Lead	85, 86	kerosene emulsion	90
Arsenite of Soda	88	lead arsenate	85, 86
Blackberry:		lime	91
general treatment for	55	lime sulfur	92
Black leaf 40	94	nicotine sulfate	94
Blossoms, spray injury	36	paris green	87
Bordeaux Mixture	62 to 72	poison bait	98
Bridge Grafting	27	pyrethrum	97
Cabbage and Cauliflower:		resin-lime mixture	89
general treatment for.....	58	soap	95
Cherry, spraying treatment and calendar	45	tobacco dust	93
Cherry Diseases:		Insect Powder	97
leaf spot	41	Kerosene:	
ripe rot	42	disinfectant	2
Cherry Insects:		emulsion	90
curculio	43	Lead Arsenate	85, 86
slug	44	Lime:	
Codling Moth	22, 34, 38	description of	67
		testing of	76
		as an insecticide	91

Lime Sulfur Mixture	75 to 79	Poisoned Bait for Cut Worms.....	98
Lime Sulfur vs. Bordeaux Mixture	37	Potato Diseases:	
Lime Sulfur, self boiled..	80, 81	blight	56
Melon:		scab	56
general treatment for	57	Potatoes:	
Mice, Injury by	26	general treatment for	56
Mildews of Grape	52	Potato Insects:	
Nicotine Sulfate	94	blister beetle	56
Orange Rust, Raspberry	55	Colorado potato beetle	56
Orchard Heating	9	flea beetle	56
Paris Green	87	Pyrethrum	97
Peach:		Rabbits and Mice, Injury by.....	26
spraying treatment calendar	46	Raspberry:	
Peach Diseases:		general treatment for	55
brown rot	46	Resin-Lime Mixture	89
fruit rot	46	Self boiled Lime Sulfur	80, 81
leaf curl	46	Snowy Tree Cricket	31
scab	46	Soap:	
Peach Insects:		as an insecticide	95
borer	46	Spraying:	
curculio	46	codling moth	38
Pear:		general directions	60
blight	39	injury to blossoms	36
slug	40	lime sulfur	82
Plum Diseases:		Spray Injury	37
fruit rot	49	(See Bordeaux and Lime Sulfur	
leaf spot	50	Mixtures.)	
Plums:		Squash:	
general spraying treatment for...	51	general treatment for	57
Plum Insects:		Strawberry Rust or Leaf Spot.....	53
curculio	47	Tobacco Dust	93
plant lice	48		

SPRAYING PRACTICE FOR ORCHARD AND GARDEN

BY S. A. BEACH.

INTRODUCTION.

This bulletin tells briefly how to fight the more common insect pests and plant diseases which infest Iowa orchards and gardens, especial attention being given to the apple. The directions are up-to-date and are based upon the work of scientific investigators and the experience of practical fruit growers. While they are given to meet the peculiar needs under Iowa conditions, they are nevertheless general, and the strength of the mixtures and number of sprayings will need to be varied somewhat to meet changing conditions.

GET READY IN TIME.

Spraying must be done at the right time and very thoroughly to meet the best success. Everything should be ready in ample season, so that when the right time comes the work can be done at once. The insects and fungi do not wait for the tardy fruit grower. While he is hunting up pumps, nozzles, hose, and poisons they keep right at work. When at last he is ready to spray they may be so thoroughly intrenched that he can do but little to dislodge them, whereas if he had begun the fight in time he might have kept them well under control. For these reasons it is best to get the necessary materials and apparatus in hand before spring opens. Moreover, the materials may often be bought more cheaply in winter than after the spraying season opens, and active demand advances the prices.

APPLE

DISEASES.

1. **Bitter Rot.** Begins with small, sunken, decaying, bitter spots on the fruit which may extend and rot the whole apple. It also cankers the branches. It causes some damage in southern Iowa, but becomes more troublesome further south. Use bordeaux six weeks after blossoms fall, and from one to three times afterwards at intervals of two to three weeks, according to the severity of the disease.

The bitter rot fungus lives over winter in the cankers on the twigs and limbs, from which it spreads to the foliage and fruit during the growing season. Cut out and burn all **cankered** wood. This work can be done best when there are no leaves on the tree. Treat wounds as directed in discussing the blight in 2.

2. Blight. Fruit spurs, twigs, and even large limbs and portions of the trunk die with blight during the growing season after it has caused the leaves suddenly to wither and turn brown. The leaves do not immediately fall but remain hanging to the dead wood. The blight makes cankered patches on limbs and trunk in which the bark is sunken and discolored. In some cases trees blight to death. Some varieties, such as Yellow Transparent and Willow Twig apples, and Hyslop and Transcendent crab apples, are very apt to blight in this region, while others, as Ralls Genet and Duchess of Oldenburg, do not blight so readily. This disease also is found on the pear, quince, mountain ash, and some other species.

When the blight first appears cut immediately all affected branches far enough below the blight into the sound wood to insure getting all of the disease out. Likewise chisel out the canker spots on the limbs and trunk, if they are deep enough to reach through the bark into the wood. Before making a new cut, dip tools in disinfectant solution of corrosive sublimate, 1 part to 1,000 of water, tablets for which may be gotten at the drug store, or wipe with waste saturated with kerosene to kill the germs. Also disinfect the wound thoroughly with the corrosive sublimate solution and completely cover all cut surfaces immediately with paint made from the best white lead and raw linseed oil. Do not spread the paint beyond the surface exposed by the cut.

Since blight lives over winter in the margins of the spots blighted the previous season, the trees should be inspected thoroughly every fall or winter and again just before blooming to cut out all of the "hold over" blight.

Plant lice, beetles, and other insects spread the disease, particularly in nurseries. It is important to keep the stock free from them.

Bees carry the blight from flower to flower, therefore keep trunk and body of the main limbs free from fruit spurs.

Rapid, succulent growth offers favorable conditions for the quick development of the blight, therefore have the soil thoroughly underdrained and try to get a steady, uniform rate of growth. It may be found advisable to check tree growth by putting the orchard in clover sod for a time, but it should be remembered that tough sod around the trees robs Iowa fruit growers of vastly more fruit than the blight does.

3. Black Rot. (Canker, New York apple tree canker.) Fruit affected by it in storage turns black. The rot may gain entrance to the fruit while it is hanging to the trees, getting in most readily through bruised or broken places in the skin. In some of the summer and early fall apples, especially in the case of such kinds as Alexander and Wolf River, they may begin turn-

ing black while on the tree. The same disease causes brownish spots on the leaves and sunken cankered spots on the twigs and larger branches. It lives over winter in the cankered wood and rotted fruit. Spray as for scab. Cut out cankers as for blight to prevent the harboring and spreading of the disease.

4. Blotch. This disease is caused by a fungus which forms cankers on the twigs and fruit spurs and even on the larger limbs and body of the tree. It also forms small yellowish or brown spots on the leaves and blotches on the fruit with fringed or irregular, ray-like margins. (See Fig. 1.) It is probably the most destructive apple disease found in the southern border of the apple belt and in the Ozark region is said sometimes to kill the trees of varieties which are especially susceptible to the disease. It is scarcely known in central Iowa but occurs more frequently in southern Iowa.

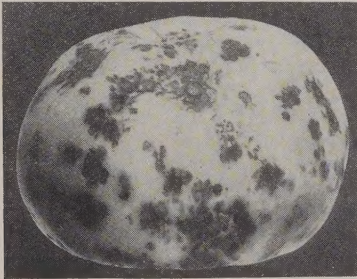


Figure 1—Apple Blotch

Infection comes largely from the cankered spots on the twigs and branches and begins about four or five weeks after the blossoms fall. It cannot be controlled with the lime sulfur mixture, but may be kept well under control by the timely and thorough application of bordeaux mixture, formula 4-4-50. Begin spraying with bordeaux mixture about four or five weeks after the blossoms fall, and continue at intervals of two to three weeks till August 1. The later sprayings are quite important, because if the disease is not held under control it may attack the forming fruit buds and thus cut down the percentage of bloom for the following season.

Among the varieties which are especially subject to injury by this disease may be named Northwestern Greening, Missouri Pippin, Ben Davis, Black Ben Davis, Gano, Arkansas Black, Willow Twig, and Maiden Blush. Among those which are affected little or not at all are Grimes, Jonathan, Winesap, and York Imperial.

5. Brown Rot. (Soft rot. Ripe rot. Same as brown rot of plum.) This fungus, *sclerotinia fructigina*, is everywhere present. The least break in the skin gives it easy entrance into the fruit. Loss of fruit in storage from this disease follows when the skin is cut by finger nails or punctured by fruit stems or broken in any way.

Pick the fruit with stems on. In wrapping and packing, do the work in such a way that there will be no puncturing by stems. Protect from injury by insects and diseases by spraying as outlined in 34.

Rainy weather late in the season after prolonged drought may cause growth cracks in the fruit through which this fungus may gain entrance to the flesh. To avoid this, maintain uniform rate of growth by thorough tile drainage and by early and frequent cultivation to conserve the soil moisture and keep the skin of the fruit in active growing condition.

6. Cedar Rust. The rust which appears on the leaves of apple trees is caused by a fungus, *roestelia pyrata*. It is found on native wild crab apples and their hybrids, and on cultivated crab apples more frequently than on the apple. Certain varieties of the apple, as Wealthy for example, are peculiarly susceptible to this disease.

One stage in the life history of this fungus is spent on the red cedar where it forms the characteristic cedar galls which in the warm rains of spring send out long, thick, gelatinous threads containing spores. When the threads become dry and break away the spores are distributed by the winds.

Apple rust is not readily controlled by spraying. Some benefit is obtained perhaps by spraying with lime sulfur mixture at the time the rust spores are being disseminated, but a more effective way, where it is possible, is to cut down any red cedar trees near the apples troubled with the rust.

7. Fly speck. This forms clusters of little round, black specks on the fruit. It does no harm except to injure the appearance of the apples. It is controlled by spraying as directed in 34.

8. Frost injury. Late spring frosts may make the fruit more or less rough or russet and even misshapen and the leaves blistered and crinkled. In some cases frost injury on the fruit resembles spray injury so closely that it is impossible later in the season to distinguish between them.

9. Orchard heating as a means of preventing loss of fruit from spring freezes is discussed in Circular No. 22 of this Experiment Station, copies of which may be had on application to the Director.

10. Orange Rust. See Cedar rust, 6.

11. Pink Rot. See Storage rots.

12. Rust. See Cedar rust, 6.

13. Sooty Blotch. This is caused by a surface fungous growth which makes smoky or sooty looking patches on the fruit which is injured only in appearance. Spray as directed in 34.

14. Storage Rots. The various storage rots may be best prevented by storing only sound fruit with unbroken skin. Pink rot is well defined by its name. When it occurs it is usually found on scab spots and so the same treatment which prevents the scab controls this disease. Brown rot, or soft rot, finds entrance chiefly through broken places in the skin. It spreads even in the cool temperatures of cold storage. Treat as directed in 34. Bitter rot, black rot and other fungous troubles of stored apples should be prevented by orchard spraying as directed.

15. Scab. This is generally the most destructive disease of the apple. It makes spots varying from the size of small specks up to large patches. It may check the growth of the apple so that it becomes one sided or misshapen and may cause it to crack. By injuring the skin it opens the way for other fungous diseases to finish the destruction. It causes dark olive brown or nearly black spots on the leaves. By injuring them, it prevents the proper development of the crop of fruit and also of fruit buds for the next crop. Spray as directed in 34.

The most important single treatment for scab appears to be the one just before blooming. Spray then with especial thoroughness. The more completely scab is put under control at that time, the less trouble will it give later in the season.

INSECTS.

16. Borers. Several kinds of borers work in the apple tree. Usually they are found in the trunk but sometimes in the larger limbs. Their presence is usually shown by a discoloration of the bark and by their castings. The flatheaded borer and the roundheaded borer are the species most common in this State.

17. Flatheaded Borer. The adult of this insect is a steel-colored beetle flattened above and with irregular depressions on the wing covers. It lays its eggs in the bark late in June or in July. When these hatch the grubs at once gnaw their way into the sapwood where they feed from one to three years before reaching full size. They then go deeper into the solid wood, pupate, and finally emerge as adult beetles. The larva is characterized by a large, broad, flat head.

Examine the trees at least once a year and dig the borers out with a sharp knife or kill them by ramming a flexible wire into the burrows.

To prevent egg laying paint the trunks and bases of larger limbs, about the middle of June with Portland cement mixed to a creamy consistency with skim milk. Work it well into the crotch and all crevices in the bark.

Recently a good deal of prominence has been given to the use of white lead and pure raw linseed oil applied as a paint on the trunks of young trees for a protection against mice, rabbits, and borers. Some experimenters report good results with this material and others report injurious results. It is usually agreed that there is danger of injuring the trees by the paint unless the white lead is pure and unless the linseed oil is pure and raw. Boiled linseed oil or paints which contain dryers have proven injurious. In using this material it is advised that the tree be first cleared of borers and the trunk be made perfectly clean. Then paint it at least a depth of two inches below the ground surface to a height varying from one and one-half to two feet, taking care to fill completely every crack and crevice.

18. Roundheaded Borer. The adult of this insect is somewhat larger than that of the flatheaded borer and is marked lengthwise by two broad white lines extending the full length of the body. The larva is more cylindrical in outline than that of the flatheaded borer and has a round head. Its habits of egg-laying and feeding are similar to those of the flatheaded borer but the grub requires only about a year to reach its full growth. Treatment is the same as for the flatheaded borer.

19. Bud Moth. The larva of this moth is a small brown caterpillar with a black head. It gets to be about a half inch long. These insects live over winter in small cases firmly attached to the bark of the twig, at that time being but about one-eighth inch long. Early in spring they bore into the buds and sometimes eat into the twig. They attack both flower and leaf buds, fastening the parts together with silken threads forming a nest under the protection of which they live and feed.



Buffalo Tree Hopper

The best time to treat the bud moth is just before the buds burst, using lead arsenate or paris green. Later it is under cover within the bud or in a nest of leaves where it is well protected against spraying treatments.

20. Buffalo Tree Hopper. This is a small bug of bright grass green color. Its peculiar form is shown in Figure 2. It feeds upon all kinds of succulent plants, especially such as are

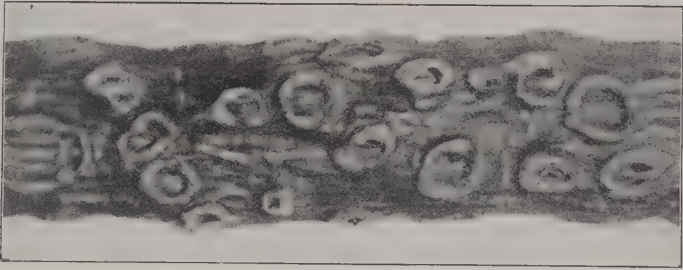


Figure 3—Buffalo Tree Hopper Injury (Enlarged)

found growing beneath trees in orchards or groves. It damages young apple trees by cutting slits in the twigs and smaller branches in which it lays its eggs. Figure 3. These slits are so made that an oval piece of bark is cut free from the wood. Where these scars are numerous the whole branch may become bark bound, stunted, and warped out of shape. The harm is greatest in young trees. One of them badly attacked even for a single year becomes bark bound and stunted so that it never recovers. Where the hoppers gain a foothold in nurseries the trees are rendered unsalable.

The fact that the young nymphs must find tender vegetation at comparatively short distance from the tree in which they are hatched makes it possible to starve them out by following the practice of clean culture in the nursery or orchard during the summer months.*

21. Casebearers. The cigar casebearer and the pistol casebearer, so named from the shape of their cases, are insects which may do a considerable amount of injury but which may be controlled by spraying properly. The adults are moths measuring about one-half inch from tip to tip of the wings. The larvæ hibernate in cases attached to twigs. In spring they feed on the opening buds and the new foliage till full grown, living all the time in cases which are readily seen projecting from the surface of the bud or leaf. They also attack the flowers and fruit.

Spray as directed in **34.**

22. Codling Moth. It is this insect which is commonly found in "wormy" apples and it causes larger financial loss to the apple growers than any other. The moths appear at blossoming time and lay their eggs, which are oval, whitish discs, upon the fruit or even on twigs and leaves. The well known

*Summers, Iowa Exp. Sta. Bul. 49, 1900.

apple "worms" hatch from these eggs in about a week and gnaw into the apple, usually through the blossom end. The larvæ of the second brood more often enter on the side of the fruit. The "worms" are full grown in twenty or thirty days. They generally leave the apple by coming out of the side and pupate in silken cocoons under loose bark near the base of the tree or under loose rubbish on the ground beneath.

By wrapping the trunk with a piece of burlap and examining it about once a week, the extent to which the second brood is present may be learned from the number of cocoons beneath the wrapping.

About nine or ten weeks after blooming the second brood begins to fly. The larvæ of the second brood live through the winter and come forth as the first brood of moths the next spring. Treat as directed in 34.

23. Curculio. Doubtless the plum curculio does more injury to the apple crop in Iowa than any other insect except the codling moth. It is a snout beetle about $\frac{1}{4}$ inch long and of a dark grayish color. The snout is long and slender and may be folded under the body. The beetle winters under rubbish or in the soil and in early spring begins feeding on the opening leaves. After fruit sets it may gnaw little holes in the fruit, but it does most damage by laying its eggs in the fruit, cutting a crescent flap at the place where the egg is laid.

This insect infests the plum, cherry, and peach, as well as the apple. Comparatively few of its larvæ develop in the apple but they develop freely in the plum and sweet cherry. They develop less readily in the sour cherry and peach. Since damage to peach, cherry and plum often results from the fruit rot fungus entering through the wounds made by the curculio, any treatment which destroys the curculio tends to lessen the other injury.

The apple curculio is similar to the plum curculio in its life history, but according to Crandall it does much less injury to the apple.*

Treat as directed in 34 for apples, 45 for cherries, 51 for plums, and 46 for peaches.

24. Oyster Shell Scale. This is at present by far the most important of the scale insects on the apple in Iowa. It resembles an oyster shell in form (Figure 4) and is about $\frac{1}{8}$ inch in length. The insects hibernate as minute white eggs under the old scales. The eggs hatch during the latter part of May or early June, depending on the season. For a few days after hatching the young may be seen as small whitish lice crawling about on the bark but they soon fasten to the bark and become

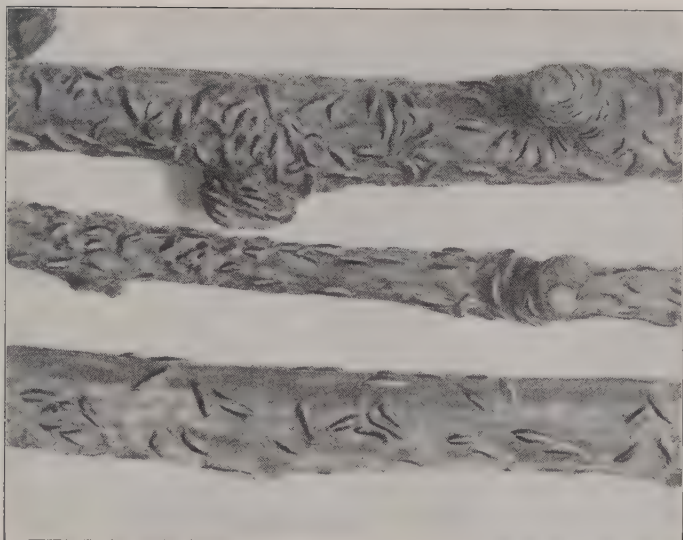


Figure 4—Oyster Shell Scale (Enlarged)

covered with a scale which protects them against sprays. They may be brought under control by annual systematic treatment as directed under 34.

25. Plant Lice. These well known little soft-bodied insects take their food from the juices of the plant by means of sucking mouth parts. They pass the winter in the egg form. Under favorable conditions after hatching in the spring they multiply very rapidly and may cause very serious injury. They cause the leaves to curl, stunt the fruit and dwarf the new growth of twigs.

Spray early before leaves curl, using nicotine sulfate as directed under 34. It may be combined with lime sulfur and lead arsenate if desired.

26. Rabbits and Mice. Rabbits and mice sometimes damage nursery stock and orchard trees greatly by gnawing through the bark. Rabbits may also cut off twigs and in the case of young trees may cut off the trunks close to the ground. The injury is usually done in the winter but may be begun in the fall soon after the leaves drop.

Spraying the trunks with lime sulfur solution of the same strength as for scale insects, 78, has been tried at this station for the past three years and has given excellent results as a

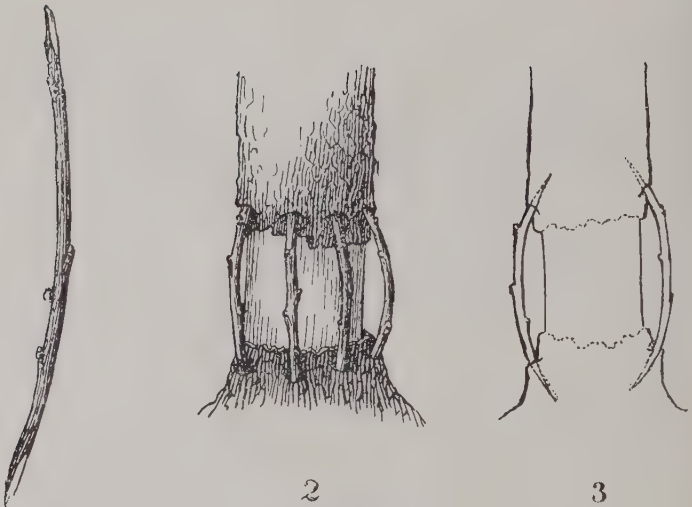


Figure 5—Methods of Bridging Over Injury to Trees
Pen sketch adapted from Thomas by W. P. Wheeler

preventive of injury from mice and rabbits. Make the first treatment soon after the leaves drop. Cover the trunk and branches thoroughly with the mixture and repeat the application if necessary to keep the bark thoroughly covered.

27. Bridge Grafting. Orchard trees which have been girdled may often be saved by what is called bridge grafting. This consists in bridging the injured parts by means of cions of the last season's growth, thus connecting the part below the wound with that above. First trim the bark around the injured parts. Then sharpen the ends of the cions to a wedge-shape and fit tightly into the layer of new wood just beneath the bark, called the cambium layer. (Figure 5.) Cover the union at the end of the cions with grafting wax, (see 28) completely to exclude the air. Also wrap the wound with cloth to protect it from drying out, and likewise cover the wax with old muslin to keep it from being melted by the sun. If the lower edge of the wound is near enough to the ground to make it practicable to do so, it is better to cover it three or four inches deep with fresh earth.

Where the trees are very young and the girdling is severe, cutting the trunk off below the wound is probably the best treatment. The exposed part of the stub should at once be coated with grafting wax. Select the best sprout that starts and support it by tying it to a firm stake until it is stocky enough to withstand strong winds without danger of being

broken off. When the sprout is well started dress the stump so that it may heal over readily. Cut the stub slanting at the base of the sprout so that it will shed water. Then cover the wound with paint made of pure white lead and raw linseed oil, to protect it from water and from disease germs. Do not spread the paint beyond the cut surface. This method should produce a tree of bearing age sooner than one could be grown from a replanted nursery tree.

Where the trees have been covered by deep snow the girdling may occur a foot or more above the ground. In that case the tree may be cut off and the stump grafted with cions of the variety desired.

28. Grafting Wax. Melt together four parts, by weight, of resin, two parts of beeswax, and one part of beef tallow or raw linseed oil. Apply while moderately hot with a brush or dauber. A supply of the wax may be kept on hand by taking the mixture when hot and pouring it into water. When it is sufficiently cool, work with the hands until the mass assumes a buff color. Make into balls and wrap with waxed paper to prevent the balls from sticking together.

29. San Jose Scale. This is a round scale insect about the size of a pinhead with a black point in the center of the mature scale. It gets its food by sucking the juices from the bark of the tree. There are several broods in a season and they multiply very rapidly. The scale causes small red spots on the fruit. The San Jose scale is generally regarded as the worst scale insect pest of deciduous orchards. Through the efficient work of the state entomologist, Iowa has thus far been kept practically free from this insect except in two or three limited districts.

Treat as directed under **34**.

30. Scurfy Scale. This insect gets its name from the fact that it often encrusts the bark, giving it a peculiar scurfy appearance. It is a whitish, pear shaped scale, about $\frac{1}{8}$ inch in length. It hibernates as purplish eggs under the old scales.

Treat with lime sulfur mixture as recommended for scale insects in **34**.

31. Snowy Tree Cricket. The damage done by this insect is most severe upon raspberry canes but it also works on grape wood. It injures the cane by cutting slits in which the eggs are



ECANTHUS NIVEUS
EGG PUNCTURES

Figure 6—Snowy Tree Cricket Injury

laid. (See figure 6.) A long line of punctures is made, so weakening the cane that it is likely to break off during the winter or in early summer.

Professor H. E. Summers recommends cutting and burning the old wood containing eggs and spraying the raspberry canes with an arsenical poison after the last fruit has been gathered.*

32. Tent Caterpillars. The presence of tent caterpillars in an orchard is always evident from the unsightly tents which they spin among the branches. The eggs are laid in July in gluey brown rings or masses about the smaller twigs. The caterpillars emerge from the eggs early in the spring and start work at once. The insects from each egg mass form a colony and devour the leaves in the vicinity of the nest.

Spray as directed under **34**.

33. Woolly Aphis. This plant louse is easily detected by the bluish white, downy or woolly covering which it excretes. Colonies of these insects are often found in cavities or crevices of the bark or the scars of old wounds or on the twigs. They are also found about the base of the tree and on the roots. It is chiefly harmful because of its injury to the roots, causing the formation of galls and abnormal enlargements which are sometimes mistaken for the crown gall. Farther south it becomes a

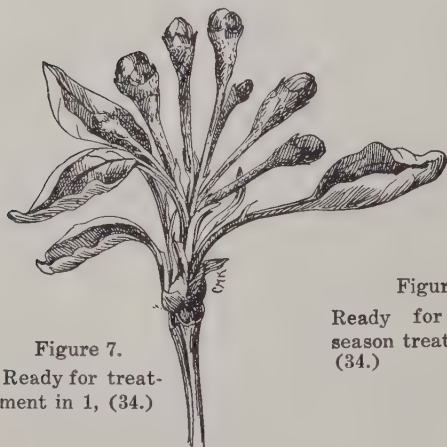


Figure 7.
Ready for treat-
ment in 1, (34.)

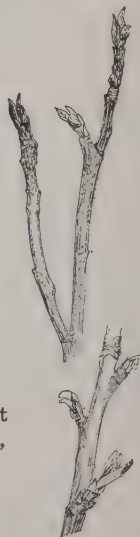


Figure 8.
Ready for dormant
season treatment in 7,
(34.)

Figures 7 and 8—Apple Bud Stages for Spraying

*Summers Iowa Exp. Sta. Bul. 49, 1900.

more serious pest than in Iowa. It is especially injurious to nursery and young orchard trees.

Spray the trunks and branches of the tree with kerosene emulsion, 1 part to 5 parts of water. Where the lice infest the roots, dig away the soil to a depth of about four inches over a diameter of about four feet, make a liberal application of fine tobacco dust, and replace the soil.

Northern Spy shows remarkable resistance against the attacks of woolly aphis and for this reason in localities where the woolly aphis is troublesome it is being used as a stock upon which to work other varieties of the apple. Among other varieties which have been mentioned as showing resistance to root aphis Miajestin, Collins or Champion and Delicious.

34. GENERAL TREATMENT FOR APPLES.

When to spray.	What to use and what for.
<p>1. After the cluster buds expand and before the blossoms open. See figure 7.</p>	<p>Bordeaux mixture 3-3-50, see (64), or lime sulfur at strength given in (78) for apple scab, canker, and leaf spot.</p> <p>Lead arsenate 3 pounds to 50 gallons, for curculio, bud moths, casebearers, canker worms, tent caterpillars, and other leaf-eating insects.</p> <p>The most important single treatment for apple scab. Important for curculio and other insects named.</p>
<p>2. Just as the last blossoms are falling.</p>	<p>"Blackleaf 40" see (94), if needed for plant lice, (25).</p> <p>Lead arsenate 2 pounds to 50 gallons of water for codling moth and curculio as directed in (85).</p> <p>The most important single treatment for codling moth. Important for curculio and effective against other leaf-eating insects.</p> <p>The next treatment, No. 3, may be combined with this, but when the trees are drenched as they should be at this spraying there will be greater danger of spray injury, but the injury may not be enough to equal the added expense of giving treatment 3 separately.</p>
<p>3. Immediately following 2.</p>	<p>Lime sulfur at strength indicated in (78) for apple scab and other diseases. May be combined with 2 as above indicated.</p>

34. GENERAL TREATMENT FOR APPLES.

4. Ten to twenty days after 3. If cloudy, wet weather prevails, spray in ten days.

Lime sulfur as in 3 for same diseases. Lead arsenate 2 pounds to 50 gallons for leaf-eating insects.

Where bitter rot and blotch are very troublesome use bordeaux mixture 4-4-50 instead of lime sulfur.

5. About 9 weeks after 4, i. e. in late July or early August.

Bordeaux mixture 4-4-50, (65) for apple blotch, bitter rot and late attacks of scab.

Lead arsenate 2 pounds to 50 gallons for second brood codling moth and other leaf-eating insects.

Very important in fighting second brood codling moth, bitter rot, and blotch.

6. Ten to twenty days after 5.

Repeat 5 if needed for either second brood codling moth, blotch, bitter rot, or late attack of apple scab.

7. Dormant Season. In spring just as the buds begin to break. See Figure 8.

Lime sulfur for San Jose scale, oyster shell, bark louse, scurfy bark louse, and other scale insects. Use at strength indicated for use in dormant season against San Jose scale in (78).

35. Special Treatment. Where long neglected orchards are being sprayed for the first time, or where there are special invasions of canker worms, bud moths, casebearers, or other leaf-eating insects, it is advisable to begin spraying earlier than the time indicated for treatment 1 in the preceding schedule.

Spray just as the green tips of the first leaves burst through the buds as directed at the bottom of the schedule under "dormant season" treatment. Use lime sulfur as indicated in 78 for San Jose scale and other scale insects. It is good also for scab and other diseases. Use lead arsenate 3 pounds to 50 gallons for leaf-eating insects, the same as directed under 1.

DO NOT SPRAY THE BLOSSOMS.

36. Much damage may be done by spraying when the trees are in bloom. Such treatment prevents many of the blossoms from setting fruit. It also poisons many insects which are valuable because they assist in cross-pollinating the blossoms and thereby in many cases insure a much better setting of the fruit. When the trees are very full of blossoms, spraying in bloom may not be disastrous because not all of the blossoms open at the same time and therefore not all are killed. But

whenever the bloom is scant, spraying the trees in full bloom is almost sure to destroy the larger portion of the crop.

LIME SULFUR VERSUS BORDEAUX MIXTURE.

37. Apples which have been sprayed with lime sulfur generally have a smoother, brighter skin than those which have been treated with bordeaux mixture. They sometimes show more or less spray injury before midsummer in a roughening of the skin, particularly where the trees have been drenched. Later, when excessively hot weather is experienced, injury of a more serious character, evidently of the nature of sunscald, may come on both fruit and foliage.

On the other hand, spray injury to the fruit which sometimes follows the use of bordeaux mixture comes on mostly before July 1 while the skin of the apples is comparatively tender and more readily permeable by the liquid copper compounds. After the skin becomes firmer and loses its pubescence there appears to be very much less liability to injury from bordeaux mixture.

Under Iowa's climatic conditions lime sulfur commonly causes much less serious spray injury than bordeaux mixture in the earlier part of the season, but whether it is as reliably efficient in keeping the scab under control is still an open question. It does not control those later appearing apple diseases, the bitter rot and the blotch. These are more destructive farther south but they are found in Iowa and particularly in portions of southern Iowa. They may be controlled by the proper use of bordeaux mixture. We are still advising that the bordeaux mixture be used also for that most important single treatment for the apple scab, namely, after the cluster buds expand but before the blossoms open. We recommend dilute lime sulfur for all treatments for apple diseases which are given after the blossoms fall until the first of July.

SPRAYING FOR CODLING MOTH.

38. The so-called one spray method of controlling the codling moth has been brought into prominence in the Rocky Mountain and Pacific coast states through the work of Doctor E. D. Ball of the Utah experiment station, and Professor A. L. Melander of the Washington station. It consists in spraying very thoroughly in a period beginning just as the last petals are falling from the blossoms and continuing for the few days thereafter in which the calyx remains open. Ball recommends a driving spray under 200 pounds pressure for the purpose of forcing the poison past the stamens into the lower calyx cup. The spray is directed downwards into the face of the apple clusters so that the blossom end of every apple may be squarely hit. For this purpose the sprayers work from a tower and the

end of the spray rod is bent at an angle so as to direct the spray downwards upon the apples.

The orchards of the Mississippi valley and the eastern states must be sprayed more than once to keep diseases under control, but the fruit growers in these regions should not lose sight of the fact that the most efficient single spray against the codling moth is that of the one spray method just described.

In fighting the codling moth it seems, in the light of our present knowledge, that there is less danger of spray injury if lead arsenate is used alone immediately after the blossoms fall, hardly waiting for the last petals to drop, than if combined either with bordeaux mixture or lime sulfur. It has been shown that bordeaux mixture applied at this early period is sometimes followed by spray injury. Lime sulfur is much less apt to cause injury at this time but does sometimes. Some observations indicate that this is more apt to occur when the trees are drenched than it is if the spray is applied only in the form of a light mist in such a way as to cover all parts of the tree but without drenching. This point has not yet been conclusively settled for bordeaux mixture, but it evidently holds true for lime sulfur. Since drenching to fill the blossom end of every apple with the poison, is necessary for the most effective work against the codling moth it may be better to leave out both bordeaux mixture and lime sulfur from this treatment. Then the fear of spray injury will not interfere with drenching as thoroughly as needs to be done for the best control of the insect pest.

If the orchardist is willing to take the risk of spray injury from drenching the tree with the lime sulfur, this treatment may be combined with the next one as indicated in the schedule, in **34**.

This application should be given if possible with a pressure of from 175 to 200 pounds with a Vermorel type of nozzle either of the ordinary capacity or one like the "Friend," with a large capacity. Ball recommends the bordeaux nozzle but Quaintance finds that the Vermorel type of nozzle gives as good results.*

PEARS

Follow the same general line of spraying for insects and diseases as that indicated for apples in **34**.

39. Blight. Treat as recommended under apple in **2**. Some of the most successful pear growers in Iowa plant the trees in sod and dig or mulch about the tree for a distance of 3 to 4 feet from the trunk. This treatment tends to keep the tree from

*Quaintance, et. al., Bureau Ent., U. S. Dept. Agr., Bul. 80, Part 7, 1911.

making such a rapid and succulent growth as gives favorable conditions for the blight to do most injury.

40. Slugs. These are soft-bodied insects which skeletonize the leaves. The first brood begins to come on in central Iowa about the middle of June and the second brood in late July or early August. Spray with lead arsenate, 2 pounds to 50 gallons, upon the first appearance of the insects, or if near the ripening season for early pears, dust instead with fresh slaked lime powder.

CHERRIES

41. Leaf Spot. One of the worst diseases of the cherry in Iowa is the leaf spot which is caused by the shot hole fungus, *Cylindrosporium padi*, Karsten. It is more injurious in Iowa than it is in eastern cherry growing regions. Very often it attacks our cherry trees so fiercely that by midsummer they become nearly or quite leafless. When seriously injured in this way they are more apt to be winterkilled than trees which hold their leaves till fall and ripen their wood well before winter sets in. This leaf spot, whether in nursery or orchard, may be practically prevented by spraying with bordeaux mixture, but unfortunately spraying the orchard at the best time for fighting the disease is apt to make a coating which will show on the fruit when it gets ripe. This does not injure the fruit but it may hinder its sale. The fruit of early varieties, like Early Richmond, can usually be picked before the disease takes off much of the foliage and then the trees may be immediately sprayed; but late ripening varieties, like English Morello and Wragg are often quite badly defoliated before the fruit is ripe and one must choose between losing the leaves and having the spray show on the ripe fruit. In the experience of many Iowa growers varieties like the Morellos having dark juice have been more susceptible to this disease. Leaf spot does not start as early in the season as does the apple scab, so when the cherries need to be sprayed for that alone the treatment need not be begun till the blossoms fall.

42. Ripe Rot. *Sclerotinia fructigina*. This disease, which is so injurious to the plum crop, and particularly to the domestica and Japanese plums, sometimes injures cherries not only by rotting the fruit but by damaging the blossoms and the first tender growth of the twigs in spring. Fight the curculio and also treat with lime sulfur as directed in the following schedule.

43. Plum Curculio. This may sting the cherry fruit and cause it to be "wormy." Spray as soon as the blossoms fall and again after ten to fourteen days, using either lead arsenate at the rate of 3 pounds to 50 gallons or an equivalent amount of some other arsenical poison as directed in **45**.

44. Cherry Slug. This insect is a small, slimy, soft-bodied creature which skeletonizes the leaves. It is easily destroyed by dusting or by spraying the foliage with poison as directed in 45.

GENERAL TREATMENT FOR CHERRIES.

When to spray cherries.	What to spray with and what for.
1. Just before the blossoms open.	Bordeaux mixture (64) or lime sulfur (78) for fruit rot. Arsenate of lead (85) for curculio. Very important for fighting curculio.
2. Just after the blossoms fall.	Repeat 1 for fruit rot, leaf spot slug, and curculio. Important.
3. 10 to 15 days after 2.	Use ammoniacal copper carbonate (74) or lime sulfur for fruit rot and leaf spot. Bordeaux should not be used at this time as it would show on the ripe fruit.
4. Just after fruit is picked.	Bordeaux mixture for leaf spot, with lead arsenate for slugs and other insects. Important.
5. From 2 to 3 weeks after 4.	Repeat 4. Important.
6. Whenever slugs first come on the leaves. In middle Iowa the first brood begins to appear about the middle of June. The second in late July or early August.	Lead arsenate or hellebore (96) or soap solution (95) or fresh slaked lime powder. Paris green is more liable to burn the leaves than is lead arsenate.
7. When lice first appear and before the leaves curl.	Nicotine sulfate (94).

PEACHES

46. GENERAL TREATMENT FOR PEACHES.

FOR THE DORMANT SEASON.

When to spray.	What to spray with and what for.
Before the buds get large, certainly before April first.	Bordeaux mixture (64) or lime sulfur (78) for leaf curl and brown rot.
Peach Tree Borer.	Dig out borers in spring and fall or treat trunks as indicated in (17).

FOR THE GROWING SEASON.

When to spray.	What to spray with.
1. Shortly after blooming when the fruit is bursting the shucks or calyxes.	Arsenate of lead 2 lbs. to 50 gallons milk of lime made from about 2 lbs. fresh lump lime.(85) Very important for curculio.
2. 2 to 3 weeks after 1.	Self-boiled lime sulfur (80) for brown rot and scab. Arsenate of lead 2 pounds to 50 gallons for curculio. Important.
3. About a month before the fruit ripens.	Self-boiled lime sulfur for brown rot and scab. Early varieties may not require this treatment.

PLUMS

47. Plum Curculio. This insect makes a puncture in the tender young fruit in which it lays its egg. It then cuts a crescent flap around the puncture, making a characteristic wound. The egg soon hatches into a larva, commonly called "a worm," which feeds upon the fruit and often causes it to drop prematurely. Often the wormy fruit starts to rot before it drops and thus helps to spread the rot fungus to other fruits. Spray with arsenate of lead, using from 3 pounds to 4 pounds to 50 gallons just before the blossoms open and again as soon as they fall. Two weeks later spray with 2 pounds arsenate of lead to 50 gallons. Paris green might hurt the leaves if used.

When the insect is very abundant jarring may also be practiced. A convenient "catcher" is made of cotton sheeting stretched over a frame mounted on low wheels. One side is slit to allow the cart to be pushed directly under the tree. The tree is then jarred and the curculio which are caught upon the sheet are swept into a box hung under the center of the sheet from whence they are later taken and destroyed. Jarring should begin as soon as the blossoms fall and continue from two to three weeks. Early morning is the best time to do this work.

Clean cultivation continued into September helps to keep the curculio under control.

48. Plant Lice. Several kinds of plant lice, or aphides, attack the plum. They work on the under side of the leaf so that it curls and often drops. They multiply very rapidly. On nursery stock they may often be fought quite successfully by cutting off the infested tips promptly and destroying them or dipping in nicotine sulfate, **94**, but in the orchard this is hardly practicable and probably the best that can be done is to spray

with nicotine sulfate or with whale oil soap, one pound to about seven gallons of water, as soon as the lice appear and before the leaves curl.

49. Fruit rot. *Sclerotinia fructigina*. This disease causes much loss to plum growers by rotting the fruit and sometimes also by destroying the blossoms and the tender shoots in spring. It is particularly destructive in Iowa to plums of the domestica or European class, such as Lombard, or Spanish King, German Prune, and Blue Damson, and also to the Japanese plums. It finds easy entrance to the fruit through punctures made by curculio or other insects. It may be partly controlled by fighting the curculio thoroughly and by spraying with lime sulfur as indicated in 78.

50. Leaf Spot. *Cylindrosporium padi*, K. This is often quite injurious to the plum. The same disease attacks the cherry as described in 41. It may be controlled readily by spraying, as there indicated.

51. GENERAL TREATMENT FOR PLUMS.

When to spray.	What to spray with and what for.
1. Just before the blossoms open.	Arsenate of lead (85) for curculio. Very important. Bordeaux mixture (64) or lime sulfur (78) for brown rot.
2. Just after the blossoms fall.	Arsenate of lead (85) for curculio and other leaf eating insects. Important. Bordeaux mixture (64) or lime sulfur for brown rot and leaf spot. Important.
3. About 15 days after blossoms fall.	Repeat 2.
4. Soon after the middle of June.	Repeat 2.
5. Late July or early August.	Lime sulfur or ammoniacal copper carbonate or eau celeste soap (73) for fruit rot and leaf spot.
6. When lice first appear and before the leaves curl.	Nicotine sulfate (94.)
7. Whenever black knot is found.	Cut out all knots and burn them. Make the cut at least 3 or 4 inches back of the knot so as to get all of the fungous threads.

Do not use paris green on plums nor bordeaux mixture on Japanese plums because of liability to injure the foliage.

The Japanese plum may be sprayed with arsenate of lead and self-boiled lime sulfur as directed in 80.

GRAPES

52. GENERAL TREATMENT FOR GRAPES.

When to spray.	What to spray with and what for.
1. When the first leaves are one-third grown.	Bordeaux mixture (64) for mildews and black rot. Important. Add lead arsenate 4 lbs. and molasses 1 gallon to 50 gallons for flea beetles if needed.
2. Just before the blossoms open.	Bordeaux mixture (64) for mildews and black rot. Lead arsenate 3 lbs. and molasses 1 gallon to 50 gallons of water or of bordeaux mixture for grape root worm, rose chafer, berry moth, and curculio if needed.
3. Just after the fruit sets.	Repeat 2. Important.
4. 10 to 20 days after 3.	Repeat 2.
5. 10 to 20 days after 4.	Repeat 2 if black rot or berry moth is abundant.
Special treatment about the last of June or first of July when beetles become most numerous and before egg laying begins.	
	Lead arsenate 3 lbs., molasses 1 gallon, to 50 gallons of bordeaux mixture or water for grape root worm. Clean cultivation during May and June will kill many of the pupæ of this insect.

Lime sulfur must not be used on grapes. The lead arsenate may be omitted if the insects mentioned are not troublesome.

53. GENERAL TREATMENT FOR STRAWBERRIES.

When to spray.	What to spray with and what for.
When growth begins and later as often as necessary.	Bordeaux mixture (64) for "rust" or leaf spot.
After picking the fruit.	Mow and burn over on a windy day.
At first appearance of the leaf roller.	Arsenical poison (85 & 87) every week if necessary but not after fruit is half grown.

54. GENERAL TREATMENT FOR CURRANTS AND GOOSEBERRIES.

When to spray.	What to spray with.
1. When leaves first appear and at intervals of about 2 weeks until fruit is half grown.	Lime sulfur (78) or bordeaux mixture (64) for mildew.
2. When "worms" first appear.	Paris green (87) or lead arsenate (85) for the "worms." Bordeaux mixture (64) for leaf spot.
3. When fruit is nearly half grown.	Repeat if needed. If "worms" appear later use hellebore (96).
4. After fruit is picked.	Bordeaux mixture (64) for leaf spot.
5. About 2 weeks after 3.	Repeat 3.
6. When lice first appear and before the leaves curl.	Nicotine sulfate (94).

55. GENERAL TREATMENT FOR RASPBERRIES, BLACK-BERRIES, AND DEWBERRIES.

When to spray.	What to spray with and what for.
When orange rust appears. Note.—This disease is easily recognized by the bright orange color on the under side of the leaf. The whole cane looks sickly.	Dig out diseased plants at once and burn root and branch.
When anthracnose and other cane diseases are doing serious damage.	After leaves drop in fall or in early spring, the whole patch may be cut and thoroughly burned over. In some cases such treatment gives very good results but in others it fails to control the anthracnose. Anthracnose may be checked by spraying with bordeaux, beginning on the new shoots when they are from 6 to 8 inches high and repeating at frequent intervals during the growing season, but the probabilities are that it will not pay.
When "worms" appear on leaves.	Spray with lead arsenate (85) up to the time the fruit sets but after that use hellebore (96) as needed.

56. GENERAL TREATMENT FOR POTATOES.

When to spray.	What to spray with and what for.
<p>Begin when plants are about 8 inches high or when beetles first appear and spray at intervals of from 10 to 15 days till growth stops.</p> <p>Spray more frequently in hot, damp weather and less often in dry weather.</p>	<p>Bordeaux mixture for early blight and rot, combined with lead arsenate, 3 pounds to 50 gallons, for flea beetles, blister beetles, and Colorado potato beetles. Apply the bordeaux mixture strong, using at least 1 pound of copper sulfate to make 8 gallons of the mixture.</p>
<p>Soak uncut seed potatoes two hours, but not longer.</p>	<p>To prevent potato scab, use commercial formalin (40 per cent solution) 1 pint to 30 gallons of water. This is enough for twenty bushels of seed. It can be used several times.</p>

57. GENERAL TREATMENT FOR CUCUMBERS, SQUASHES, AND MELONS.

When to spray.	What to spray with.
<p>When young plants come through the ground; repeat frequently.</p>	<p>Tobacco dust (93) for striped beetle.</p>
<p>About 1 month after planting, repeat at intervals of 10 days.</p>	<p>Bordeaux mixture (64) for blight, flea beetles and striped beetles.</p>
<p>When lice or aphids first appear.</p>	<p>Nicotine sulfate (94). Be particular to spray the under side of the leaves.</p>
<p>Borers.</p>	<p>Plant a few early squashes between the rows of the late varieties as a trap crop. As soon as the early crop is harvested remove and burn the vines. When the borers have already attacked the vine cover the joints with earth in order to develop secondary root systems for the plant in case the main stem is injured.</p>

58. GENERAL TREATMENT FOR CABBAGE AND CAULIFLOWER.

When to spray.	What to spray with.
When "worms" appear. Repeat when necessary.	Paris green or other arsenical poison in dust, or in resin lime mixture. Do not apply poison after heading begins.
Lice or aphids.	Bury the first affected plants.

59 GENERAL TREATMENT FOR ALL KINDS OF PLANTS.

All leaf eating insects such as slugs, caterpillars, beetles, etc.	Paris green (87) or other arsenical when insects first appear.
Sucking insects such as plant lice and true bugs.	Tobacco dust or nicotine sulfate (94) or soap or kerosene emulsion (90). Small plants or ends of twigs are best treated by dipping.
Scale insects such as scurfy bark louse and San Jose scale.	Spray with the lime-sulfur (78) in spring before the buds open.

APPLYING SPRAY MIXTURES

60. How to Spray. In spraying to prevent fungous diseases such as apple scab the best results follow when the leaf is covered most completely and permanently with the spray mixture. The same is true of spraying with insect poisons. This may be best accomplished by making a spray so fine that it will fall on the leaf in mist-like particles and dry there. The aim should be to cover every leaf in this way and at the same time so far as possible avoid making the leaves drip. In spraying with lime sulfur it is especially needful to avoid drenching the foliage. The foliage can be covered in a better way with a mist-like spray than with a coarse spray, and at less expense of time and materials.

With a pressure of from 100 to 120 pounds the spray is finer than with the same nozzle under but 70 pounds pressure. When a fiercely driving spray is needed, as for example for forcing the mixture into every crevice of the bark when spraying for San Jose scale, or for filling the lower calyx cup of the apple in spraying for codling moth, it is well to have a pressure of 200 pounds and use a nozzle like the Friend or others of the Vermorel type.

In all cases where the purpose is simply to cover the foliage lightly but completely it is best to use a nozzle like the Ver-

morel which gives a cone-shaped spray, and the pressure need not be more than 125 pounds.

Special directions for spraying self-boiled lime sulfur are given in 82.

61. Agitators. Spraying outfits should be equipped with good agitators. The heavy ingredients of the mixtures settle rapidly. If the liquid is not kept thoroughly agitated it at times is too strong and at other times is too weak. This applies particularly to paris green, lime sulfur, and self-boiled lime sulphur.

MAKING SPRAY MIXTURES

62. Various substances are used by fruit growers and gardeners in fighting insects and fungi. Those materials used against fungi are fungicides; those which are destructive to insects are insecticides.

FUNGICIDES.

63. Bordeaux Mixture. Bordeaux mixture has come into general use for fighting fungous diseases of orchard, farm and garden crops, such as apple bitter rot, potato blight, cherry leaf spot, grape mildew, etc. The strength of the bordeaux mixture should be varied to suit the conditions under which it is used; for example, a much stronger mixture should be used in treating the potato blight than is required in spraying apples.

64. Strength of Bordeaux Mixture. The strength of bordeaux mixture is commonly indicated by stating the number of pounds of copper sulfate and lime to be used in making 50 gallons. Thus the 4-4-50 formula calls for 4 pounds copper sulfate and 4 pounds of lime for 50 gallons which is one pound to twelve gallons. This is the formula recommended for general use in spraying pears, grapes, cherries and plums (except the Japanese group), and apples for bitter rot and blotch. In treating potatoes for blight the strength should be increased to 6-6-50. In spraying apples after blooming and before July the strength is reduced to 3-3-50 to lessen the danger of spray injury.

65. Bordeaux Mixture, 4-4-50 Formula. (To make 50 gallons.) Copper sulfate (blue vitriol), 4 pounds.

Quicklime (not slaked) not less than 2 and 2-3 pounds, nor more than 4 pounds.

Water, 50 gallons.

Dissolve the copper sulfate* and dilute to from 25 to 35 gallons.

*It dissolves more quickly in hot water than in cold. Do not dissolve it in an iron or tin vessel because it would corrode the metal.

Slake the lime and add enough water to it to complete the required 50 gallons, then pour the two solutions together, and the bordeaux mixture is made. Strain it into the spray tank through a wire cloth strainer such as is indicated in Fig. 9, to catch any lint or coarse particles which might clog the nozzles. Lastly, add any arsenical poisons which are to be combined with the bordeaux mixture.

An exception to this rule should be made when homemade arsenate of lead in dilute mixture is to be combined with the bordeaux mixture. In that case combine the arsenate of lead mixture with the lime wash before it is poured into the copper sulfate solution to make the bordeaux mixture.

66. Caution. Dilute both the lime and the copper sulfate as much as the formula will allow and then mix. Do not mix the ingredients in concentrated form before diluting. Diluting the ingredients as much as possible before mixing gives a mixture in which the particles stay in suspension for a long time so that comparatively little agitating is required to insure an even distribution of the mixture from the spray tank. Mixing the ingredients in concentrated form results on the contrary in forming heavy particles which settle readily, necessitating violent and continual churning to secure an even distribution of the mixture.

The copper compounds in the bordeaux mixture give it its value as a fungicide. The lime is added chiefly to prevent injury to the foliage. It has the additional advantage that in combining with the copper sulfate a sticky substance is made which holds to the leaves well even in rainy weather and shows plainly on the trees so that one can easily see how well the spraying has been done.

67. Lime prevents injury to the foliage by combining with the copper into an insoluble compound. Enough lime must be used to take up all of the free copper sulfate or the mixture may burn the leaves badly. This requires about two thirds as much by weight of unslaked lime as of copper sulfate. More than this may be used but it is best not to have too great an excess of lime, at most not more than an amount equal in weight to the weight of the copper sulfate as indicated in the formulae stated.

68. Purity of Lime. Pure stone lime contains nothing but calcium oxide. Commercial lime contains varying amounts of some other substances, such as compounds of iron, aluminum, magnesium, etc. It may be tested for purity as directed in **76**. It should be at least 90 per cent pure calcium oxide.

69. Never Use Air Slaked Lime. Screen out all air slaked dust or partly air slaked lumps and choose only fresh, clean,

firm, stone lime. Lime which has become partly air slaked should not be used.

If the lime is of a kind that slakes fast, first break it into rather small lumps; then add successively small quantities of water till it starts to slake and generates heat. From time to time as the slaking progresses add enough water to keep the lime covered all the time, and stir it as much as is necessary to keep it from "burning." Give time enough to the slaking so that all the fine gritty particles will become as nearly slaked as possible. If it can be obtained fresh as it is needed it is well to weigh what is to be used for each tank and let it be slaking while the previous tankful is being sprayed.

Some of the lime used in Iowa slakes very slowly. In handling it cover it with a moderate amount of water and leave it unstirred till it is completely slaked.

After the lime has slaked into a smooth paste keep it covered with water to exclude the air. It may thus be kept in good condition for a considerable time. It is not necessary to weigh it, because the test hereafter described shows when enough lime has been added to make the bordeaux mixture. This plan permits of slaking the lime in large quantities. It is better to do this than to let the lump lime stand and become partly air slaked before it is used.

Avoid the "new process" or powdered lime. It is apt to be more or less air slaked and its use is therefore the more liable to be followed by spray injury.

70. Making Bordeaux Mixture from Stock Solutions. Where large quantities of bordeaux mixture are needed it is convenient to keep the copper sulfate on hand in a stock solution and hold the slaked lime in the form of paste covered with water as above described. These ingredients can then be diluted as they are needed.

71. Stock Solution of Copper Sulfate. A convenient stock solution of copper sulfate is made by keeping more copper sulfate in it than the water can dissolve. In this case the solution is saturated and no matter how much it evaporates it can not get stronger. It then holds about 50 ounces of copper sulfate to the gallon; practically 3 pounds to the gallon. To make 50 gallons of bordeaux mixture of the 4-4-50 formula take 1 and 1-3 gallons of this stock solution and dilute it to about 25 gallons as directed in 65 and 66. Take about as much lime paste as would be made by slaking 4 pounds of quick lime and dilute it to nearly 25 gallons. Pour the lime into the copper sulfate, stir thoroughly and then test by adding a drop of ferrocyanide potassium.

72. Ferrocyanide of Potassium Test. If enough lime has been added to combine with all of the copper in solution the drop

will not change color. If there is not enough lime present the drop of ferrocyanide potassium turns at once to a dark reddish brown color; more lime should then be added. When the ferrocyanide solution does not change color this shows that enough lime has been added to take up all of the copper. Then it is well to add about a third as much more lime, to insure an abundant excess, particularly if paris green or any other arsenical poison is to be used with it.

The ferrocyanide of potassium, also called yellow prussiate of potash, is a very poisonous yellow salt. Dissolve it in about ten times its bulk of water and it is ready for use. It is inexpensive.

73. Eau Celeste and Soap (Modified). Eau Celeste and Soap is a good fungicide to use in place of bordeaux mixture when the fruit is nearly full grown. On the whole it is not so effective as bordeaux mixture, but it has the advantage of showing less plainly on the ripe fruit.

Formula.

Copper sulfate, 1 pound.

Ammonia strong (26° Beaume), 3 pints.

Soap, 1 pound.

Water, 50 gallons.

Dissolve the soap in 10 gallons of water. In a separate vessel (not iron or tin) dissolve the copper sulfate in 40 gallons of water and add the ammonia; stir well and add the soap.

74. Ammoniacal Copper Carbonate and Soap. Ammoniacal Copper Carbonate and Soap is also used for spraying fruit that is nearly ripe, because it shows less plainly than does bordeaux mixture.

Formula.

Copper carbonate, 6 ounces.

Ammonia strong (26° Beaume), about 3 pints.

Soap, 1 pound.

Water, 50 gallons.

Dilute the ammonia somewhat with water and use as much of it as is necessary to dissolve the copper carbonate; add water to make 40 gallons. Dissolve the soap in 10 gallons of water and pour into the copper carbonate solution.

The dissolved copper carbonate loses strength when left exposed to the air, but it may be kept all right in stoppered bottles or jugs.

75. Lime Sulfur and Self Boiled Lime Sulfur. Lime sulfur was first brought into use in orchard work as a remedy for the San Jose scale. It has proved very efficient against scale insects in general, also other forms of insect life which the

trees harbor during winter. In the dormant season strong mixtures are used for the most part, being sprayed on the trees usually just before the leaves come out in the spring.

It was early found that lime sulfur, besides being a first-class insecticide, has value as a remedy for some of the fungous diseases. This has led to testing it in dilute solutions against diseases of foliage and fruit during the growing season. To what extent it can be advantageously used for this purpose is a question which just now is being made the subject of active and extended investigation.

The term lime sulfur, as commonly used, refers to some mixture made by boiling together lime and sulfur by means of artificial heat. It is not a uniform compound. It is prepared and used at varying strengths for different purposes. It is made in concentrated form which is called the "concentrate" in distinction from the various diluted forms which are applied to the trees and may be bought or made at home. The home-made lime sulfur may either be diluted for immediate use or stored as a concentrate till needed.

The following list includes, so far as we know, those manufacturers of commercial lime sulfur who are located nearest to Iowa fruit growers.

Rex Co., Omaha, Nebraska..... .Rex brand.

Grasselli Chemical Co., Chicago, Illinois....Grasselli brand.

Sherwin-Williams Paint Co., Chicago, Illinois.

Bean Spray Pump Co., Cleveland, Ohio.....Niagara brand.

Self boiled lime sulfur is very different in its composition from lime sulfur. No heat is used in making it except that which comes from slaking the lime. See 69.

The following directions for making lime sulfur are adapted freely from the Geneva bulletins as indicated.

HOMEMADE LIME SULFUR.*

76. Lime. Use only fresh lump lime free from dust or from partly air slaked lumps. No air slaked lime should be used. The lime should test not less than 90 per cent pure lime (calcium oxide) and should not contain more than 5 per cent magnesium oxide. It is best to buy the lime under a guarantee as to its composition.¹

*Parrott and Schoene, N. Y. State (Geneva) Sta. Bul. 330.

¹Lime may be tested as to percentage of impurity by boiling 2 ounces of fresh lump lime with 4½ ounces of fine flowers of sulfur. Slake the lime and make it into a thin uniform paste; add the sulfur and dilute to one quart. Boil gently one hour, keeping it well stirred and adding water every few minutes to bring it up to the one quart mark. Then let it cool and pour it into a graduate to stand over night, being careful to get in all the sediment. Thirty cubic centimeters of sediment indicates 5 per cent of impurities, and fifty centimeters indicates 10 per cent of impurities.

Instead of the graduate above mentioned, a glass cylinder may be used. After

77. Sulfur. Either flowers of sulphur or light or heavy sulfur flour may be used.

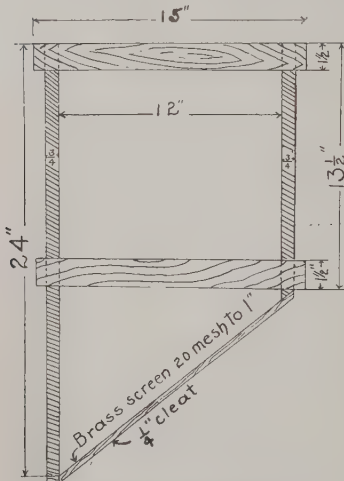
Formula and directions:

Lump lime (pure)**	36 pounds
Sulfur.....	80 pounds
Water.....	50 gallons

Break the lime into rather small lumps. Place in kettle, or if live steam is used, in barrel or vat, and slake it with hot water. Make a smooth paste of the sulfur with water. Add this to the lime as slaking commences, and mix thoroughly. When the lime is all slaked, add the rest of the 50 gallons of water, and enough more as needed from time to time during the boiling to keep the quantity up to 50 gallons. When steam is used for cooking, extra water may not be needed. Use a measuring stick notched at the 50 gallon mark to show how much water needs to be added to keep the volume up to 50 gallons. Do not let it drop more than an inch below the 50 gallon mark at any time. Dash a little cold water into the kettle to stop the

boiling for a moment while measuring. Keep well stirred to break up lumps and prevent caking on the sides of the kettle. Boil vigorously from 45 minutes to one hour or till the sulfur is all dissolved. Use a kettle of sufficient capacity to prevent loss from boiling over.

When through with the boiling bring the volume up to 50 gallons and strain it without trying to separate it from the finer sediment which passes through the sieve. The coarse particles which do not go through the strainer are kept for later boilings. Fig. 9 illustrates a strainer which works well.



Strainer for Spray Mixtures

all the sediment has settled, test with the Geneva lime tester which may be obtained from Bausch & Lomb Optical Company, Rochester, New York, together with directions for use. This tester is provided with two scales. The reading on one scale gives the percentage of purity of lime. On the other scale it gives the number of pounds of lime to use in order to have the equivalent of 36 pounds of pure lime. Lime should not be used if it tests less than 90 per cent purity. Van Slyke, Bosworth and Hedges, New York State (Geneva) Sta. Bul. 329.

**If the lime is but 95 per cent pure, use 38 pounds, and if it is but 90 per cent pure use 40 pounds.

The heavier and coarser particles which do not go through are washed down to the lower edge of the sieve, thus leaving the rest free for the straining of the mixture.

If the mixture is to be used at once it should be diluted as indicated in **78** and **79**. If it is to be stored it should be kept from the air to prevent crystals from forming. Fill the barrels full and cork them tight. If it is to be used within a few days, the mixture may be kept in an open barrel or tank if covered with a thin layer of paraffine or oil to exclude the air.

When cool test the clear liquid with a hydrometer and mark the reading on the barrel or storage tank to indicate what dilution should be made when the mixture is used.

78. Dilution of Lime Sulfur. If no hydrometer* is at hand dilute for spraying dormant trees, as for San Jose scale, so that the spray mixture will contain from 15 to 16 pounds of sulfur to 50 gallons. This means about one gallon made by the foregoing formula to five gallons of water. For spraying apple trees in leaf dilute till the mixture contains but 4 pounds of sulfur to 50 gallons. This will usually take 1 gallon made by the foregoing formula to about 20 gallons of water.

For treatment against San Jose scale the commercial lime sulfur is usually diluted at the rate of 1 gallon to 8 to 12 gallons of water. For summer spraying of apples, it is diluted at the rate of 1 gallon to 30 to 40 gallons of water, according to the density of the concentrate.

It usually tests in density from 30 degrees to 35 degrees by the hydrometer. Its density varies and it needs to be known exactly so as to determine how much to dilute it to get the particular amount of sulfur per gallon which may be desired in the spray mixture.*

The homemade concentrate is apt to vary more than the commercial brands do in the strength or density of the clear liquid. By following the dilution table given herewith, more uniform spray mixture may be had.

This dilution table is made on the basis of using a solution containing 4.75 ounces of sulfur per gallon, or 14 4-5 pounds per 50 gallons, when diluted ready for use against the San Jose scale, and 1.04 ounces of sulfur per gallon, or 3 1-4 pounds per 50 gallons, when diluted for summer spray as against apple scab. It may be used at the same strength in spraying the pear, plum, and cherry. After it has been diluted for use on

*Hydrometers with a range of 0 to 38 degrees Beaume are suitable for making this test. They cost about a dollar. They may be bought through druggists, from the wholesale dealers or from Bausch and Lomb Co., Rochester, New York, Eimer and Amend, New York, or Whithal Tatum Co., New York. They form an almost essential part of the equipment for the proper use of lime-sulphur.

dormant trees the mixture should test about 4 1-2 degrees on the Beaume scale. When diluted for use on apple foliage it should test about 1 degree Beaume.

79.

DILUTION TABLE.*

Density of Solution in degrees, Beaume.	Sulfur in one gallon of solution.	Dilution for San Jose Scale. For 1 gallon Lime-sulfur solution	Dilution for summer spray for 1 gal. Lime-sulfur solution
36	2.99 lbs.	9 gals. water	45 gals. water
35	2.88 lbs.	8 $\frac{3}{4}$ gals. water	43 $\frac{1}{4}$ gals. water
34	2.77 lbs.	8 $\frac{1}{4}$ gals. water	41 $\frac{1}{2}$ gals. water
33	2.67 lbs.	8 gals. water	40 gals. water
32	2.53 lbs.	7 $\frac{1}{2}$ gals. water	37 $\frac{3}{4}$ gals. water
31	2.43 lbs.	7 $\frac{1}{4}$ gals. water	36 $\frac{1}{4}$ gals. water
30	2.30 lbs.	6 $\frac{3}{4}$ gals. water	34 $\frac{1}{4}$ gals. water
29	2.20 lbs.	6 $\frac{1}{2}$ gals. water	32 $\frac{3}{4}$ gals. water
28	2.08 lbs.	6 gals. water	31 gals. water
27	1.99 lbs.	5 $\frac{3}{4}$ gals. water	29 $\frac{1}{2}$ gals. water
26	1.87 lbs.	5 $\frac{1}{4}$ gals. water	27 $\frac{3}{4}$ gals. water
25	1.76 lbs.	5 gals. water	26 gals. water
24	1.65 lbs.	4 $\frac{1}{2}$ gals. water	24 $\frac{1}{4}$ gals. water
23	1.55 lbs.	4 $\frac{1}{4}$ gals. water	22 $\frac{3}{4}$ gals. water
22	1.45 lbs.	3 $\frac{3}{4}$ gals. water	21 $\frac{1}{4}$ gals. water
21	1.35 lbs.	3 $\frac{1}{2}$ gals. water	19 $\frac{3}{4}$ gals. water
20	1.26 lbs.	3 $\frac{1}{4}$ gals. water	18 $\frac{1}{4}$ gals. water
19	1.18 lbs.	3 gals. water	17 gals. water
18	1.11 lbs.	2 $\frac{3}{4}$ gals. water	16 gals. water
17	1.04 lbs.	2 $\frac{1}{2}$ gals. water	15 gals. water
16	0.97 lbs.	2 $\frac{1}{4}$ gals. water	14 gals. water
15	0.90 lbs.	2 gals. water	12 $\frac{3}{4}$ gals. water

80. Self Boiled Lime Sulfur. Self boiled lime sulfur has not given very good results when used against the apple scab but it is effective against the scab and the brown rot or fruit rot on the peach and against the curculio when combined with arsenate of lead. The same line of treatment is being tried with the plum, but it appears from evidence thus far secured that plums of the native and the European species may be safely treated with boiled lime-sulfur the same as is used on the apple.

The arsenate of lead by poisoning the curculio acts indirectly as a remedy for the fruit rot. Peach foliage is injured by spraying with either the boiled or the commercial lime sulfur, even though very dilute.

*Van Slyke, Bosworth and Hedges, N. Y. Sta. (Geneva), Bul. 329-438, 1911.

Particular care must be taken to cool the self boiled lime sulfur according to directions, or injury may result.

The accepted method of using self boiled lime sulfur against the brown rot of the peach has been best worked out by Scott and his coworkers. The following directions are freely adapted or directly quoted from one of his recent bulletins on this subject.*

81. Preparation of Self Boiled Lime Sulfur. The 8-8-50 formula is recommended. This mixture can best be prepared in rather large quantities—say enough for 200 gallons at a time, making the formula 32 pounds of lime and 32 pounds of sulfur to be cooked with 8 or 10 gallons of water, and then diluted to 200 gallons.

“The lime should be placed in a barrel and enough water poured on to almost cover it. As soon as the lime begins to slake the sulfur should be added after first running it through a sieve to break up the lumps. The mixture should be constantly stirred and more water added as needed to form a thick paste at first, and then gradually a thin paste. The lime will supply enough heat to boil the mixture several minutes. As soon as it is well slaked, water should be added to cool the mixture and prevent further cooking. It is then ready to be strained into the spray tank, diluted and applied.

“The stage at which cold water should be poured on to stop the cooking varies with different limes. Some limes are so sluggish in slaking that it is difficult to obtain enough heat from them to cook the mixture at all, while other limes become intensely hot on slaking and care must be taken not to allow the boiling to proceed too far. If the mixture is allowed to remain hot fifteen or twenty minutes after the slaking is completed, the sulfur goes into solution, combining with the lime to form sulfids, which are injurious to peach foliage. It is very important, especially with hot lime, to cool the mixture quickly by adding a few buckets of water as soon as the lumps of lime have slaked down. The intense heat, violent boiling, and constant stirring result in a uniform mixture of finely divided sulphur and lime, with only a very small percentage of the sulfur in solution. The mixture should be strained to take out the coarse particles of lime, but the sulfur should be carefully worked through the strainer.”

82. Application of Lime Sulfur. “The necessity of keeping the mixtures thoroughly agitated while spraying can not be too strongly emphasized. Both self boiled lime sulfur and arsenate of lead settle readily, and if the spraying outfit is not

*Scott and Ayres. Control of Peach Brown Rot and Scab. U. S. Department of Agriculture. B. P. I. Bul. 174:15.

equipped with a good agitator the mixture will not be evenly distributed, and some of the trees will be oversprayed, while others will receive an insufficient application. In power sprayers the propeller type of agitator is the most satisfactory for this work. The early application of lime sulfur may be made rather heavy, but the last spraying should be made with fine nozzles. The aim should be to give the fruit a uniform coating of a mist-like spray. Heavy drenching of the trees should be avoided."

83. Lime Sulfur for San Jose Scale. In fighting the San Jose scale the trees must be completely covered with strong lime sulfur before the foliage appears and preferably just as the buds are beginning to break. Dilute to the strength indicated for use against San Jose scale in the dilution table in **79**. This treatment helps to control the oyster shell bark louse, scurfy scale, and certain other hibernating insects, and also to some extent some of the plant diseases.

The spray should thoroughly coat every portion of the bark to the end of every twig. Spray from the tip towards the base so as to drive the mixture into every crevice of the bud scales and under every free edge of rough bark.

INSECTICIDES.

84. Insects are divided into two groups according to the general form of their mouth parts; namely, biting insects and sucking insects. Biting insects are characterized by having mouth parts adapted for chewing their food. Sucking insects have their mouth parts so formed that they can feed only by sucking their food. The potato beetle is an example of the former, while the plant louse is representative of the latter. Biting insects may be destroyed by applying poison to the plants upon which they feed. Sucking insects can not be poisoned in that way but they may be destroyed by using certain insecticides which kill them by coming in contact with their bodies. Some insects are driven away by treating the plant with some substance which is offensive to them; for example bordeaux mixture drives away certain flea beetles.

INSECTICIDES FOR BITING INSECTS.

85. Arsenate of Lead. Arsenate of lead, or lead arsenate, is a reliable insect poison and less liable than paris green to harm the foliage. It sticks well to the leaves. It may be used either alone or in combination with bordeaux mixture. Use at the rate of 2 pounds to 50 gallons unless otherwise indicated. Reliable commercial brands are found on the market.

In spraying for curculio on apple and plum just before and just after the blooming season, use 3 pounds to 50 gallons.

In very humid climates care must be taken to use the neutral lead arsenate, but no complaints have come to us of injury to foliage in Iowa from the acid lead arsenate.

The homemade lead arsenate is less expensive than the commercial brands, but some fruit growers have not been successful with it. Perhaps this has been due, at least in part, to the fact that one of the ingredients which is used in the home preparation, the arsenate of soda, is apt to contain a considerable quantity of impurities. Nevertheless by carefully following the directions given below some fruit growers are successful with the homemade mixture.

Formula, (equivalent to 3 pounds lead arsenate to 50 gallons).

Lead acetate (sugar of lead), 11 ounces.

Sodium arsenate, 4 ounces.

Water or spray mixture, 50 gallons.

Dissolve each separately in a small quantity of water, a gallon apiece will do, mix and dilute to 50 gallons with water, or with lime sulfur if that is to be used. If it is to be used with bordeaux mixture, pour it into the milk of lime before that is mixed with the copper sulfate solution. See 65. If used in water alone the precipitate is more finely divided if the lead acetate solution is first diluted to 25 gallons or more, then the solution of sodium arsenate added and the whole diluted to 50 gallons.

The sodium arsenate dissolves in water quite readily.

Lead acetate dissolves rather slowly, so it is well to dissolve it several hours before it is to be used. It dissolves more readily if a little acetic acid is added to the water. For a stock solution use soft water if convenient.

86. Stock Solution of Lead Acetate. The lead acetate may be kept on hand indefinitely in a stock solution in a manner similar to that described for copper sulfate in 71. The saturated solution at ordinary temperatures holds about 37 ounces of lead acetate to the gallon. About $1\frac{1}{4}$ quarts of it is required for the 50 gallon formula above given as equivalent to 3 pounds of lead arsenate. A little excess does no harm. Dissolve the 4 ounces of sodium arsenite and into it pour the measured stock solution of lead acetate and let it settle. Then test it by taking some of the clear liquid into a tumbler and add to it a little more of the stock solution. If a white substance forms, that signifies that more of the lead acetate is needed to combine with the arsenic, therefore add more and repeat the test till the liquid remains clear when the lead acetate is added. Then dilute with water to 50 gallons or use with lime sulphur or bordeaux mixture if so desired as directed in the first paragraph.

If the equivalent of 2 pounds instead of 3 pounds of lead arsenate is desired, take 1 2-3 pints of the stock solution instead of 1 1-4 quarts and use with it 2 2-3 ounces instead of 4 ounces of sodium arsenate and proceed as before directed.

87. Paris Green. Paris green may be sprayed in liquids or applied dry in the form of dust, using one pound of the poison to twenty pounds of common flour, land plaster or slaked lime. Flour seems the best, as it is eaten more freely by some insects. Dust should usually be applied when the plants are damp from dew or rain. When paris green is combined with bordeaux mixture be sure to have an excess of lime over what is actually required for neutralizing the copper sulfate. When used in water add twice as much lime by weight as paris green, to prevent injuring the leaves.

Paris green must never be combined with lime sulfur.

Paris green may be used in spraying apples, pears, or cherries at the rate of 1 pound to 150 gallons of bordeaux mixture or of water.

In spraying plums it is better to use lead arsenate but if paris green is used it should be at the rate of not more than 1 pound to 300 gallons of bordeaux mixture or water. If used too strong it will injure the leaves.

Paris green should not be used on peach foliage. It defoliates them.

For potatoes paris green may, if necessary, be used as strong as 1 pound to 50 gallons of bordeaux mixture or of water, but many do not use more than 1 pound to 100 gallons, and this is usually enough.

For cabbage and cauliflower add one pound of paris green to 80 gallons of resin-lime mixture. This, of course, must not be used after the plants begin to head.

88. Arsenite of Soda. The demand for a cheap substitute for paris green is met by arsenite of soda prepared by the Kedzie formula which is here given:

White arsenic, 1 pound.

Sal soda, 4 pounds (crystals).

Water, 1 gallon.

If the sal soda has changed to powdered form comparatively less of it is required to dissolve the arsenic. Mix and boil about 15 minutes or till the arsenic is all dissolved. Add just enough water to make up for that lost in boiling, then put in jugs or bottles till needed. Two quarts of this solution may be used in place of one pound of paris green by adding about 4 pounds of fresh slaked lime or by combining with bordeaux mixture in which there is an excess of lime as directed in **67**.

Keep the stock solution plainly labeled **Poison**.

89. Resin-lime Mixture. Resin-lime mixture is used in spraying plants like cabbage and cauliflower to which liquid does not stick very well.

Pulverized resin, 5 pounds.

Concentrated lye, 1 pound.

Fish oil, or any cheap oil except tallow, 1 pint.

Water, 5 gallons.

Place oil, resin, and a gallon of water in a kettle and heat until resin is softened; add lye solution made as for hard soap; stir thoroughly; add remainder of water and boil for about two hours, or until the mixture will unite with cold water making a clear, amber-colored fluid. Replace the water which has boiled away by adding boiling water to make the 5 gallons. This gives a stock solution which may be kept till needed. In using it add to the 5 gallons 80 gallons of water, 15 gallons of thin whitewash, and 1 pound of paris green or its equivalent.

INSECTICIDES FOR SUCKING INSECTS.

90. Kerosene Emulsion.

Kerosene, 2 gallons.

Rain water, 1 gallon.

Soap, $\frac{1}{2}$ pound.

Dissolve soap in water by boiling; take from the fire and, while hot, turn in kerosene and churn briskly for 5 minutes. It can be churned easily by pumping. Dilute before using with 6 to 9 parts water. For scale insects and all sucking insects.

91. Lime. Dry, fresh slaked lime is often used in combating insects having soft sticky bodies such as the rose slug and asparagus beetle.

92. Lime Sulfur. This is used both as a fungicide and an insecticide. See 75-79.

93. Tobacco Dust. Tobacco dust may be obtained from large manufacturers at a comparatively small cost. In addition to its value as an insecticide it has the advantage of acting as a fertilizer. It is useful in fighting striped beetles which infest cucumbers, squashes, and melons, and in keeping plant lice and other insects from the garden plants. It is also used against root lice, particularly the woolly aphis. For this purpose it should be worked into the ground in liberal quantities. **33.**

94. Nicotine Sulfate or Black Leaf 40. Use at the rate of $\frac{3}{4}$ pint of Black Leaf 40 and 3 pounds soap to 100 gallons of water for spraying on plant lice and other soft-bodied sucking insects. It may be used with the lime-sulfur or with the bordeaux mixture omitting the soap. The diluted form is simply known as Black Leaf.

95. Soap. Whale oil soap or other cheap soap is used for plant lice and other soft-bodied insects. It differs so much in

strength that it is well to try each lot on a little foliage before using it extensively. Use 1 pound to 6 or 7 gallons. For leaf slugs on pear or cherry use 1 pound whale oil soap or $\frac{1}{2}$ pound laundry soap to 2 gallons. When the leaves are off the trees it may be used as strong as two pounds to the gallon. It is sometimes so used in treating scale insects.

96. Hellebore. Hellebore or White Hellebore is a powder which kills both by contact with the insect and as a poison. It may be used either dry or with water. It may be mixed with three or four parts by weight of flour and dusted on the insects or it may be mixed with water at the rate of 1 pound to 25 gallons and used as spray. It is especially useful in combating "worms" on currants or gooseberries, and leaf slugs on cherries while the fruit is ripening because it may be used without danger of poisoning the fruit. Care must be taken to get a strictly fresh article. It loses strength with age.

97. Pyrethrum or Insect Powder.

Pyrethrum powder, 1 ounce.

Water, 3 gallons.

For dry application mix thoroughly one part by weight of insect powder with four of cheap flour and keep in closed vessel for 24 hours before dusting over plants attacked. Pyrethrum if fresh and pure can be made to do very effectual work. It should be kept in tightly sealed cans. If exposed but a few hours it loses strength. If the best pyrethrum can not be obtained it would be better to use some other insecticide.

98. Poisoned Bait for Cutworms. Mix one pound of paris green with fifty pounds of bran or thirty-five of middlings. A spoonful put at the base of each plant will furnish protection for cabbage or tomatoes or other transplanted plants. Some prefer to wet the mixture with sweetened water.

Another method is to spray fresh new growth of clover or any other good succulent plant with one pound of paris green to twenty-five gallons of water. Then mow it and spread in little heaps about the field.

Care should be taken to prevent poultry from getting this poisoned bait. In the garden this may be easily accomplished by putting the bait under a board near the plants. This has the additional advantage of preventing the moist bait from drying out.

